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ABSTRACT

This paper discusses the use of hypermedia as a mainstream instructional tool and what this use means for the success of all learners. Hypermedia research has not provided evidence of superiority to other instructional media. This research has, however, indicated that learner characteristics play a significant role in achievement in these new environments. Epistemological beliefs and self-regulatory skills have been demonstrated to be essential determinants of success in traditional learning environments. These beliefs and skills may be especially crucial to learning in cyberspace. This paper reviews relevant research from the educational psychology and hypermedia literature and discusses implications for the delivery of hypermedia instruction. Future research opportunities are described. (Contains 22 references.) (Author/MES)

Learning with Hypermedia: The Role of Epistemological Beliefs and Self-Regulation

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Abstract: This paper discusses the use of hypermedia as a mainstream instructional tool and what this use means for the success of all learners. Hypermedia research has not provided evidence of superiority to other instructional media. This research has, however, indicated that learner characteristics play a significant role in achievement in these new environments. Epistemological beliefs and self-regulatory skills have been demonstrated to be essential determiners of success in traditional learning environments. These beliefs and skills may be especially crucial to learning in cyberspace. This paper reviews relevant research from the educational psychology and hypermedia literature and discusses implications for the delivery of hypermedia instruction. Future research opportunities are described.

Introduction

More than half of the nation's classrooms are now connected to the Internet (Fatemi, 1999). Online high schools and computer laptops replacing books are just two of the numerous movements that will result in students accessing content knowledge in a hypermedia format. Original conceptions of the World Wide Web described a very interactive medium in which users had a great deal of control over how material was presented. In fact, Tim Berners-Lee, one of the people credited with the advent of the World Wide Web, originally envisioned web browsers as readers and *editors* of text (Berners-Lee, 1999). Unfortunately, hopes of an inherently interactive medium have not materialized. Research with instructional hypermedia has failed to demonstrate superiority over the traditional text (Dillon & Gabbard, 1998). However, when we look at specific learner characteristics, differences are often noted.

The increasing use of hypermedia for instructional purposes demands that we better understand how it affects all learners. Much of the research involving hypermedia in instruction has focused on characteristics of the medium and their impact on learning. Learner characteristics are equally important to success in any instructional setting. What are the characteristics of learners that will impact their success in these new environments? This paper reviews research from the instructional technology and educational psychology literature that demonstrates the importance of epistemological beliefs and self-regulation in learning. The implications for hypermedia-based instruction are presented.

This paper will begin with a brief review of the hypermedia research landscape. We will then describe two concepts that we believe hold a good deal of promise in understanding how all learners react to hypermedia instruction, epistemological beliefs and self-regulation. For each concept we will discuss potential implications for hypermedia learning. Finally, we will describe what type of research is necessary to provide us with a better understanding of the relationships between epistemological beliefs, self-regulation and learning with hypermedia.

Hypermedia Research

Credit for the discovery of the hypertext concept (but not the term) is given to Vannevar Bush who in 1945 described a system (the Memex) that allowed the retrieval of information based on association rather than traditional indexing (Landow, 1997). Theodore Nelson is credited with the first use of the term "hypertext" to describe this method of linking documents. The term "hypermedia" is simply an extension of the original term to incorporate the linking of other media such as images, videos and sound. These and other pioneers in the field originally envisioned hypermedia as a superior learning tool in part because it closely mimics the workings of the human mind (Tergan, 1997).

A recent review by Dillon and Gabbard (1998) explored the hypermedia literature concerning learning comprehension, learner control, and style (i.e. learner characteristics). They concluded that the benefits of hypermedia over other methods of instruction are limited. There is, however, evidence that individual characteristics play a role in success in hypermedia environments (Dillon & Gabbard, 1998). The preponderance of existing hypermedia research literature has investigated differences in user interfaces or instructional methods. Less research has been conducted that explores learner characteristics and their impact on learning in a hypermedia environment. Some of the attributes that have been studied in a hypermedia environment include ability (Repman, Willer & Lan, 1993), passive/active learners (Lee & Lehman, 1993), field independence/dependence (Jonassen & Wang, 1993), and deep vs. shallow processors (Shute, 1993). Dillon and Gabbard's review of each of these areas concluded that these characteristics might offer "the beginning of an explanation for the generally conflicting results in the literature comparing hypermedia and non-hypermedia learning environments" (p. 344). In another review of hypermedia research, Tergan (1997) concludes: "A major result of these studies is that individual learning prerequisites like differences in learning goals may override structural parameters of hypertext/hypermedia documents in affecting performance" (p. 263). We concur with these authors in the need for a better conceptualization of the impact of learner attributes in these new surroundings.

Two learner attributes that are almost completely unexplored in empirical studies of hypermedia are epistemological beliefs and self-regulatory skills. These characteristics hold promise in that they are related to each of the characteristics mentioned above that interact with achievement in hypermedia environments. For example, if one holds the epistemological belief that knowledge consists of discrete facts (see complete description below), they are less likely to deeply process instructional material (Hofer & Pintrich, 1997). In hypermedia environments, this takes on added import as we consider the decisions that the learner must make in terms of sequence of instruction and accessing supplementary materials.

Epistemological Beliefs

Epistemology refers to the study of the nature of knowledge. Researchers have shown that the epistemological beliefs held by students may have important influences on thinking and problem solving. Expanding on the work of Perry (1970) and King and Kitchener (1994), Schommer (1990) has proposed five separate epistemological dimensions corresponding to beliefs about knowledge. Each dimension is based on a continuum. The following lists the "naïve" end of the continuum for each dimension:

1. Certain Knowledge (i.e. absolute knowledge exists and will eventually be known)
2. Simple Knowledge (i.e. knowledge consists of discrete facts)
3. Omniscient Authority (i.e. authorities have access to otherwise inaccessible knowledge)
4. Quick Learning (i.e. learning occurs in a quick or not-at-all fashion)
5. Fixed Ability (i.e. ability to acquire knowledge is innate)

Research conducted with traditional instructional materials indicates that certain epistemological beliefs correlate with achievement. Schommer, Crouse, and Rhodes (1992) reported that beliefs in *Simple Knowledge* negatively affected complex problem solving. Schoenfeld (1983) investigated some of the consequences of a belief in *Quick Learning*. He reported that even experienced students who were asked to solve math problems gave up after five to ten minutes on the assumption that if they failed to solve the problem during this time, the problem could not be solved.

Implications of Epistemological Beliefs for Hypermedia

A study by Jacobson and Spiro (1995) that examined their cognitive flexibility theory briefly addressed epistemological beliefs in a hypermedia environment. They found students with simple epistemological beliefs had difficulty with the non-linear and multidimensional nature of an ill-defined hypertext system. However, the measurements used in this study were exploratory in nature and epistemological beliefs were not the focus of the study. As indicated by Jacobson and Spiro in their paper (1995), more research is necessary, but this study represents an important beginning to the application of what is known about epistemological beliefs to hypermedia learning.

Why would these differences exist? As discussed above, certain epistemological beliefs coincide with a less adequate approach to learning. The belief in *Fixed Ability* as a primary determinant of success leads students to believe that more effort does not coincide with more learning. As a consequence, the additional hypermedia tools available, such as links to definitions, diagrams, self check materials, objectives and advanced organizers, may have little positive impact. The effort required to use the hypermedia tools is less than in traditional settings (e.g. clicking on a term for a definition is easier than looking it up in the glossary). However, it still requires mental effort and thus one would expect the belief in *Fixed Ability* to be negatively correlated with use of hypermedia tools. Similarly, a student who takes a *Quick Learning* approach to hypermedia instruction will be less likely to take advantage of some of the useful tools available in hypermedia environments.

Self-regulation

Like epistemological beliefs, students' self-regulatory skills will also significantly mediate success in most learning environments (Schraw, 1998). Self-regulatory skills include, but are not limited to, the learner's ability to monitor their understanding as they read a text passage and their ability/willingness to set goals. Students who lack skills such as monitoring for understanding and goal setting tend to struggle in many learning environments (Zimmerman, 1990). Short-term instructional goals help students focus on relevant instruction and its relationship to current knowledge. Evidence suggests that students will exert more mental effort on tasks they see as attainable and when they can perceive progress towards a goal (Schunk, 1990).

Self-regulation also depends on students understanding of their own cognition. For example, skilled learners understand how much information they can retain in memory before they need to engage in an alternative approach to storing information (e.g. take notes). These learners have a wide repertoire of learning strategies from which to choose and a good understanding of when to use each.

Implications of Self-regulation for Hypermedia

Most studies that investigate self-regulation and hypermedia are concerned with teaching self-regulatory strategies within the hypermedia environment (e.g. Puntambekar & du Boulay 1997). Other studies investigate strategies used with hypermedia (Hill & Hannafin, 1997). No studies that we are aware of have investigated the relationship between these self-regulatory skills and learning with hypermedia. The learner's self-regulatory capacity is vital to their success in any learning environment, including hypermedia. The learner's repertoire of reading strategies like summarization and their willingness to invoke such strategies when appropriate, have a dramatic effect on their understanding. Highly self-regulated students are better equipped to take advantage of the hypermedia environment. Links to objectives and the opportunity to take a self-test will be of little value to students who do not take advantage of them.

One specific characteristic of hypermedia instructional materials that may cause differences in student success is the web-like organizational structure. It is clear that the learner's ability to develop new, or modify existing, schemata is an important determinant of understanding. The more complicated organizational structure of hypermedia documents (as compared to the largely linear structure of a traditional text) may hinder the success of students who have difficulty organizing topics in their mind.

Future Research

It is important to begin to research the relationships between epistemological beliefs, self-regulatory skills and achievement in a hypermedia instructional environment. These relationships should be measured with tools that have a proven record of reliability. One such measure is the Epistemological Beliefs Inventory, a well-researched measurement tool based on Schommer's (1990) five dimensions of epistemological beliefs. Students' self-regulatory skills should be measured with tools such as the Metacognitive Awareness Inventory (Schraw & Dennison, 1994), a self-report tool that determines the extent with which the learner uses strategies such as rereading (an indication of monitoring for understanding).

The hypermedia instructional materials used in such research should simulate instructional materials now commonly used. Specifically, the materials should include tools such as links to definitions, advanced organizers, objectives and self-tests. How does the use of tools such as objectives and self-check questions relate to students' epistemological beliefs and self-regulation skills? In addition, how does the choice of paths through the content relate to these beliefs and skills? For example, are students with better self-regulation skills likely to progress through the content in a more systematic fashion? These approaches can be easily collected and analyzed using computer log files.

We believe that students who hold more sophisticated epistemological beliefs and greater self-regulatory skills will perform better than their peers in the hypermedia environment. This would have useful and important implications for the delivery of instruction via hypermedia. As online-high-schools, laptops-as-textbooks, and distance learning become commonplace in our system of education, these relationships become increasingly vital.

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